A Survey On Multiresolution Image Fusion

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Abstract - *Multiresolution fusion is the process which helps to obtain the images having both high spatial and spectral resolutions by combining panchromatic (Pan) and multispectral (MS) images. The multiresolution image fusion is mostly used in remotely sensed images to improve the quality of the remote sensed images. This paper presents a survey on some of the image fusion techniques for remote sensed images like, Curvelet transform, IHS method, AR model, IGMRF method etc.*

***Key Words*: AR Model, Multiresolution image fusion, multispectral image, panchromatic image.**

1.INTRODUCTION *(Size 11 , cambria font)*

The remotely sensed images are of spatial and spectral resolutions. The ability of the sensor to capture closely spaced objects is the spatial resolution. The spectral resolution is the count of wavelength fringes in the electromagnetic spectrum to which the sensor is sensitive. Most of the contemporary satellites cannot collect high spatial resolution MS images because the signal to noise ratio of a sensor is fixed and the spatial resolution collects large number of reflected photons.

The survey consist of the different techniques and methods to improve the spatial and spectral quality as well as the speed of the remote sensing images. After the survey we have summarized the techniques and methods taken for the survey and also includes the merits and demerits.

2. LITERATURE REVIEW

The papers described below are taken for the study of the survey conducted. The each papers describes different methods and techniques which are explained as follows:

S.Ren et al. [1] defines a new image fusion method using the Curvelet transform, which represents the contour of image better and is anisotropy. The method is defined in three steps. Firstly, a histogram is plot in accordance to the match of panchromatic image and multispectral images. Secondly, the Curvelet transform of multi-spectral images and the matched panchromatic image is taken. Thirdly, different fusion techniques are used for estimating the coefficients of the Curvelet transform, such as weighted average for low-frequency coefficients and region energy for high-frequency coefficients, which results in the fusion image Curvelet coefficients. Finally, the fusion image is obtained making the resultant estimated image Curvelet coefficients in the inverse Curvelet transform. The technique of Curvelet transform has been used to fuse both IKONOS Pan and MS images of Wenchuan in Sichuan after the 5.12 earthquake.

The advantage of the Curvelet transform is that it is better in both the spatial and the spectral domains than the conventional approach methods such as the Intensity-Hue-Saturation and the discrete Wavelet transform.

S. Rahmani et al. [2] describes an Intensity-Hue-Saturation (IHS) method to increase the efficiency and high spatial resolution of pan-sharpening method. The pan-sharpening method is used to fuse a low spatial resolution multispectral image with a higher resolution panchromatic image to obtain a high spectral and spatial resolution image. In this method two new modifications have been introduced to improve the spectral quality of the image. First method describe the estimation of image adaptive coefficients for IHS depending on the primary multispectral and panchromatic images to achieve more accurate spectral resolution. The second method describes an edge-adaptive IHS method to enforce spectral fidelity away from the edges and preserves the high spatial quality and increases the spectral quality.

The advantage of the IHS pan-sharpening method is that it gives good spatial quality and is a commonly used algorithm for its speed and simplicity.

M. V. Joshi et al. [3] developed a model-based approach to multiresolution fusion of remotely sensed images to enhance the spatial resolution of the MS image to the resolution of the Pan images. The method is mainly applied on a collection of a low spatial resolution multispectral (MS) image and high spatial resolution panchromatic (Pan) image acquired on the same geographical area. The proposed fusion technique utilizes an autoregressive (AR) model, whose parameters are learnt from the analysis of the Pan data. The AR model uses the spatial correlation of each high-resolution MS channels which results in a combination of the spectral characteristics of the low-resolution MS data with the high spatial resolution of the Pan image. The main advantages of the proposed technique are: (1) the registration between the Pan and the MS images are not used. (2) During the fusion process it models the texture of the scene effectively. (3) Shows very small spectral distortion and (4) can be used in critical situations in which the Pan and the MS images are captured in slightly different areas.

The method is experimented in Landsat-7 Enhanced Thematic Mapper Plus (ETM+) and Quickbird images and obtains good result.

M. Joshi et al. [4] presented a model based approach for multi-resolution fusion of satellite images. In the model, each of the low spatial resolution MS images are modeled as noisy versions of their corresponding high spatial resolution images. A decimation matrix is estimated for each of the MS bands by using the availability of Pan and the MS image. The estimated high spatial resolution MS images are modeled as separate Inhomogeneous Gaussian Markov Random Fields (IGMRFs) and the Maximum A Posteriori (MAP) which is used to obtain the fused images. The method does not directly operate on the Pan pixel values. The advantage of the method is that it have better performance in terms of both the spectral and the spatial fidelity than other approaches.

J. Yonghong et al.'s [5] proposed an improved high frequency modulation fusion method based on MTF (Modulation transfer functions). The experiment is done in GeoEye – 1 satellite. It helps MS and PAN images with spatial resolutions of 2.0m and 0.5m respectively. The proposed method uses three steps to obtain the final fused image. First, MTF are measured from GeoEye-1 images, and then the degraded images are obtained based on MTF filters. Secondly, modulating parameter is obtained from the Minimum Mean Square Error, and image fusion is performed which is measured in the degraded version. Finally, fused images having high spatial resolution are produced. The proposed method is best both in improving resolution of MS images and protecting spectral information of MS images.

M. Choi et al. [6] defines a concept amelioration de la resolution spatiale par injection de structures (ARSIS). The wavelet-based image fusion provides high-quality spectral content in fused images but have less spatial resolution. In order to solve this problem ARSIS concept is developed using the curvelet transform because it represents edges better than the wavelets.Edges are fundamental in image representation and enhancing the edges is an effective means of enhancing spatial resolution. The proposed method provides high information in the spatial and spectral domains.

L. Alparone et.al [7] describes a novel image fusion method, appropriate for pan-sharpening of multispectral (MS) bands, based on multi-resolution analysis (MRA). In this method the process is, the sharpening of low-resolution MS bands by adding high-pass directional details which is extracted from high-resolution Pan image using the curvelet transform. The main benefit of curvelets is the ability of representing a curve as a collection of superimposed functions of various lengths and widths. The curvelet transform is a multi-scale transform, but contains directional elements. Advantage of fusion process in the curvelet domain is that the relationships between high-resolution detail coefficients of MS bands and the Pan image is more accurate and stable. Experiments are done in high resolution MS + Pan QuickBird image.

S.Li et.al [8] uses a method of compressed sensing (CS) theory which ensures the sparsity regularization of the remote sensing image pan-sharpening problem. The pan-sharpening is changed into signal restoration problem with sparsity regularization. The basis pursuit (BP) algorithm is used to resolve the restoration problem.

V. Harikumar et.al [9] developed a method based on compressive sensing (CS) and graph cuts. In the first step, assumes that both the MS and Pan images have the same sparseness. An estimation of the MS image is acquired from the Pan image using the theory of compressive sensing and l1 minimization. Second step is to obtain fused image by regularization framework. The regularization is processed by the use of truncated quadratic smoothness prior which helps in the preservation of the discontinuities in the fused image. Finally, an energy function is formed. This energy function is minimized using an efficient graph cuts method and results fused image. Advantage of the method is that the Pan and MS images are not registered.

The proposed method helps in obtaining an improved spectral and spatial quality of the fused image than the other methods. The experiments are done in GeoEye-1 Image, Quickbird Satellite Images, Worldview2 Satellite Images, and Synthetic Image.

3. CONCLUSIONS

The survey includes different techniques and methods to increase the spatial and spectral quality as well as the speed of the remote sensing images. The experimental results in the various proposed schemes ensure more secure and also the quality of the fused images in remotely sensed images. From the survey we have recognized that various techniques for enhancing the better quality of fusion method is obtained after the processing of multiresolution fusion techniques. We can choose our technique/method based on our requirements.

REFERENCES

[1] S. Ren, J. Cheng, and M. Li, "Multiresolution fusion of Pan and MS images based on the curvelet transform," in Proc. 2010 IEEE Int. Geoscience and Remote Sensing Symp. (IGARSS), 2010, pp. 472–475.

[2] S. Rahmani,M. Strait, D. Merkurjev, M. Moeller, and T.Wittman, "An adaptive IHS pan-sharpening method," IEEE Geosci. Remote Sens. Lett., vol. 7, no. 4, pp. 746–750, 2010.

[3] M. Joshi, L. Bruzzone, and S. Chaudhuri, "A model-based approach to multiresolution fusion in remotely sensed images," IEEE Trans.Geosci. Remote Sens., vol. 44, no. 9, pp. 2549–2562, 2006.

[4] M. Joshi and A. Jalobeanu, "Multiresolution fusion in remotely sensed images using an IGMRF prior and MAP estimation," in Proc. 2008 IEEE Int. Geoscience and Remote Sensing Symp. (IGARSS), 2008, vol. 2, pp. II–269–II–272.

[5] J. Yonghong, W. Meng, and Z. Xiaoping, "An improved high frequency modulating fusion method based on modulation transfer function filters," ISPRS Annals Photogramm., Remote Sens. Spatial Inform. Sci., vol. I, no. 7, pp. 285–290, 2012.

[6] Myungjin Choi , Rae Young Kim, Myeong-Ryong Nam, Hong Oh Kim, " Fusion of multispectral and panchromatic Satellite images using the curvelet transform". Div. of Appl. Math., Korea Adv. Inst. of Sci. & Technol., Daejeon, South Korea IEEE Geoscience and Remote Sensing Letters (Impact Factor: 1.81). 05/2005; 2(2):136 - 140.

[7] L. Alparone, L. Wald, J. Chanussot, C. Thomas, P. Gamba, and L. Bruce, "Comparison of pansharpening algorithms: Outcome of the 2006 GRS-S data-fusion contest," IEEE Trans. Geosci. Remote Sens., vol. 45, no. 10, pp. 3012–3021, 2007.

[8] S. Li and B. Yang, "A new pan-sharpening method using a compressed sensing technique," IEEE Trans. Geosci. Remote Sens., vol. 49, no. 2, pp. 738–746, Feb. 2011.

[9] V. Harikumar, Prakash P. Gajjar, Manjunath V. Joshi, and Mehul S. Raval, Senior Member, "Multiresolution Image Fusion: Use of Compressive Sensing and Graph Cuts", IEEE journal of selected topics in applied earth observations and remote sensing, vol. 7, no. 5, May 2014